ARTICLE

Dietary Supplement Use Among Infants, Children, and Adolescents in the United States, 1999-2002

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Objective: To describe dietary supplement use among US children.

Design: Analysis of nationally representative data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES).

Setting: Home interviews and a mobile examination center.

Participants: Children from birth through 18 years who participated in NHANES (N = 10 136).

Main Exposure: Frequency of use of any dietary supplement product.

Outcome Measure: Prevalence of use and intake of key nutrients from supplements among children.

Results: In 1999-2002, 31.8% of children used dietary supplements, with the lowest use reported among infants younger than 1 year (11.9%) and teenagers 14 to 18 years old (25.7%) and highest use among 4- to 8-year-old children (48.5%). Use was highest among non-Hispanic white (38.1%) and Mexican American (22.4%) participants, lowest among non-Hispanic black participants (18.8%), and was not found to differ by sex. The type of supplement most commonly used was multivitamins and multiminerals (18.3%). Ascorbic acid (28.6%), retinol (25.8%), vitamin D (25.6%), calcium (21.1%), and iron (19.3%) were the primary supplemental nutrients consumed. Supplement use was associated with families with higher incomes; a smoke-free environment; not being certified by the US Department of Agriculture Special Supplemental Nutrition Program for Women, Infants and Children in the last 12 months; lower child body mass index; and less daily recreational screen time (television, video games, computers, etc) ($P < .005$). The highest prevalence of supplement use ($P < .005$) was in children who were underweight or at risk for underweight ($P < .005$).

Conclusions: More than 30% of children in the United States take dietary supplements regularly, most often multivitamins and multiminerals. Given such extensive use, nutrient intakes from dietary supplements must be included to obtain accurate estimates of overall nutrient intake in children.

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MOST ADULTS IN THE United States take dietary supplements.[1-6] In the 1999-2000 National Health and Nutrition Examination Survey (NHANES), 57% of women and 47% of men reported using a supplement in the past 30 days.[6] Adult dietary supplement users in the United States typically have higher incomes and education levels, are more physically active, and have diets that more closely follow dietary guidelines than nonusers.[6-11] In contrast, little is known about supplement use by infants, children, and adolescents (henceforth *children*).

The American Academy of Pediatrics and other professional organizations emphasize diet as the best source of nutrition for healthy children.[12,13] However, since the 1930s, physicians have recommended nutrient supplements for children whom they believe are at risk of deficiency.[14,15] Because rickets continues to be a concern, the American Academy of Pediatrics recommends a supplement containing 200 IU of vitamin D per day for infants who are breastfed or who ingest less than 500 mL per day of vitamin D–fortified formula or milk and for children and adolescents without regular exposure to sunlight who ingest less than 500 mL of vitamin D–fortified milk per day and do not take a daily supplement containing at least 200 IU of vitamin D.[16-19] Other nutrients are recommended for children at risk of specific deficiencies because of their environment or lifestyles.[12,20-22]

Data on the use of dietary supplements among nationally representative samples of US children are more limited than for adults. Available data indicate that past prevalence of dietary supplement use among children was similar to or greater than that of adults.[4-7,11,23-28] The prevalence of regular vitamin or mineral supplement use in the 1976-1980 NHANES II varied from 41.7% for 1- to 2-year-old children to as low as 10.1% for 11- to 19-year-old males.[26] The 1981 National Health Interview Survey indicated that 36% of US children younger than 18 years used a vitamin or mineral supplement within the past 2 weeks.[25] (The National Health Interview Survey, conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention, is the principle source of information on the health of the US population. It has been conducted continually since 1957.) More recent data from the 1991 follow-up to the 1988 National Maternal and Infant Health Survey indicated that 54.4% of all 3-year-old children in a nationally representative sample were given a vitamin-mineral supplement in the past month.[27]

In the 1988-1994 NHANES III, young children (age, 1-5 years) exhibited the highest prevalence of supplemental vitamin and mineral use during the past month (42.0%-51.0%), with a lower prevalence through the teenage years (12-19 years; 21.4%-32.9%).[5,23,28-31] These data are the best nationally representative information available on dietary supplement intake in children during the past 30 years. This report presents the latest national estimates of dietary supplement use among US children derived from the most recent NHANES data from 1999-2002. Nutrients from supplements may provide a significant contribution to the overall nutrition of a child, which cannot be discounted in assessing overall health.

METHODS

THE NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY

The National Health and Nutrition Examination Survey is a nationally representative, cross-sectional examination survey that includes personal and family interviews, usually conducted in the home, and a medical examination in an NHANES mobile examination center. It samples the US noninstitutional civilian population using a complex, stratified, multistage probability cluster sampling design.[32,33] Participant consent is required. Participants older than 17 years sign their own consent forms. Parents sign consent forms for children younger than 18 years, though children 12 through 17 years also sign a form. While adults generally respond to the survey questions for children younger than 18 years, the children often participate.

We used combined data from the 1999-2000 and 2001-2002 NHANES data releases,[32,33] which included 21 004 individuals (of whom 10 150 were aged between birth and 18 years) with interview data and 9755 with examination data. Dietary supplement data were available for 10 136. **Table 1** presents unweighted sample sizes and weighted percentages of US children who used supplements in 1999-2002 by selected demographic and lifestyle characteristics.

UNIVARIATE ANALYSIS

Eight demographic and household characteristics (Table 1) were used as covariates in the analyses: age; race/ethnicity; annual family income; family health insurance status; household participation in the US Department of Agriculture Special Supplemental Nutrition Program for Women, Infants and Children (WIC); smokers in the household; total time spent by the child engaged in television, computer, and/or videogame screen time per day; and the child's body mass index (BMI; calculated as weight in kilograms divided by height in meters squared; only available for children older than 2 years). We categorized each child's age in months into 1 of the 5 groups used in the Dietary Reference Intakes[34]: younger than 1 year, 1 to 3 years, 4 to 8 years, 9 to 13 years, and 14 to 18 years of age. We calculated each child's BMI using measured height and/or length, weight, and age and categorized each child as underweight (<5th percentile), at risk of underweight (5th-15th percentiles), probably healthy weight (15th-85th percentiles), at risk of overweight (85th-95th percentiles), and overweight (≥95th percentile), using BMI for males and females separately based on the National Center for Health Statistics charts and the US Department of Agriculture/Agricultural Research Service Children's Nutrition Research Center categorical criteria.[35-37] The population-weighted prevalence of children in the 5 BMI categories were underweight (3.6%), at risk of underweight (5.8%), probably healthy weight (61.3%), at risk of overweight (14.4%), and overweight (14.9%). Older children had a higher prevalence of overweight or being at risk of overweight.

DIETARY SUPPLEMENT DATA COLLECTION

Participants, or their proxies if the participant was younger than 16 years, were asked if they had taken any vitamins, minerals, or other dietary supplements in the past 30 days. Trained interviewers recorded each supplement's name and manufacturer from the label, if possible, or from the participant. Participants were also asked for how long, how often, and how much they had taken each product. National Center for Health Statistics staff later obtained the label for each supplement used.

DATA PREPARATION AND CALCULATIONS

National Center for Health Statistics staff incorporated supplement-label information—including the name, ingredient contents and amount, product form, recommended intake, and intended target age of the product (infant, child, adult, or older adult)—into the data record. For supplements where National Center for Health Statistics staff could not identify a product match, the participant was coded as having taken a supplement, but no label details were included.

Dietary supplements were independently categorized in the NHANES database based on their ingredients using 2-digit codes to represent ingredient classes (eg, single botanical, single mineral, single amino acid, and multiple vitamin). The 804 individual supplements were coded into 177 dietary supplement types, then consolidated into 40 (1999-2000) and 44 (2001-2002) larger type classes, such as multivitamin and multimineral, multibotanical, and multimineral, for our analysis. All steps in the categorization were cross-checked prior to analysis. Supplement types with the highest prevalence of use are reported here.

STATISTICAL ANALYSIS

Data were analyzed using SAS, version 9.1 (SAS Institute, Cary, North Carolina), and SUDAAN, version 9.0 (RTI International, Research Triangle Park, North Carolina) statistical software programs. Standard errors were estimated using a Taylor series linearization method that incorporated sampling weights and used variance formulas appropriate for the NHANES sample design. All statistical analyses used NHANES sample weights, which accounted for unequal probabilities of selection, nonresponse, and oversampling.[38,39] Analyses were conducted on the 1999-2002 data using the 1999-2002 NHANES 4-year interview sample weights for the combined data.

Table 1. Characteristics of NHANES Sample for US Children and Percentage of US Children Who Use Supplements

Characteristic[a]	Children in NHANES, No. Children Using Supplements	Children in Sample	Children in United States Who Use Supplements, % (SE)
Total No. of participants[b]	2487	10 136	31.8 (1.3)
Sex			
M	1215	5116	30.8 (1.3)
F	1272	5020	32.8 (1.8)
Age, mo (y)			
0-11 (<1)	112	1040	11.9 (1.5)
12-47 (1- 3)	516	1638	38.4 (2.3)
48-107 (4-8)	687	1974	40.6 (2.7)
108-167 (9-13)	543	2441	28.9 (1.6)
168-227 (14-18)	629	3043	25.7 (1.2)
Race/ethnicity			
Non-Hispanic white	1023	2817	38.3 (1.8)
Non-Hispanic black	525	2915	18.8 (1.2)
Mexican American	731	3556	22.4 (1.3)
Other[c]	208	848	25.4 (2.5)
Annual family income, $[d]			
0-24 999	752	4345	21.7 (1.4)
25 000-44 999	497	1890	32.6 (2.9)
45 000-64 999	347	1172	35.5 (2.4)
≥65 000	641	1712	42.2 (2.1)
Health insurance			
Yes	2118	8187	32.7 (1.4)
No	324	1771	24.6 (3.0)
Household WIC certified in last 12 mo			
Yes	532	2756	21.8 (1.6)
No	1888	7100	34.2 (1.5)
Smoker in household			
Yes	366	2027	23.8 (1.7)
No	2081	7957	34.0 (1.5)
Child's total screen time, h/d			
<1	342	1133	38.8 (3.4)
1-2	899	3050	37.3 (1.9)
≥3	952	4090	28.6 (1.3)
Body mass index[e]			
Underweight	76	259	38.7 (3.3)
At risk of underweight	131	445	38.5 (3.7)
Probably at a healthy weight	1275	4561	34.9 (1.6)
At risk of overweight	302	1206	30.3 (2.3)
Overweight	254	1409	25.0 (2.3)

Abbreviations: NHANES, National Health and Nutrition Examination Survey; WIC, US Department of Agriculture Special Supplemental Nutrition Program for Women, Infants and Children.
[a] Selected as indicators of demographics, family income, family health, and child activity/weight status.
[b] Excludes 14 children who responded "Don't know" or refused.
[c] Includes other Hispanic individuals and other race categories, including multiracial.
[d] Annual family income levels were combined into the 4 categories based on percentage distribution of values prior to analysis.
[e] Calculated as weight in kilograms divided by height in meters squared.

Because of the large number of statistical tests employed, we chose a very conservative significance level (α=.005) instead of 5% (α=.05), so that only 0.5% of all tests would be statistically significant by chance. As seen in **Table 2**, overall differences by characteristics were tested using a Wald χ^2 statistic. We used *t* tests on unweighted and weighted frequency distributions of BMI and total screen-viewing time by age category to separately assess the interaction of age with these variables. Family income for all children younger than 19 years was classified into 1 of the following 4 categories: $0 to $24 999; $25 000 to $44 999; $45 000 to $64 999; and $65 000 or more. Values were then coded as income level 1, 2, 3, or 4, and a linear trend test, derived using a logistic regression model, was performed to assess whether or not prevalence of dietary supplement use increased with annual family income. Linear trend tests were conducted with 4 age categories (omitting infants younger than 1 year because of their small numbers) and supplement use (any and multivitamin/multimineral) and the prevalence of intake of the 6 nutrients in Table 2.

Multivariate analysis was performed using the 8 models that showed significant variation in the univariate analysis (**Table 3**). Wald and Satterwaite-adjusted *F* tests were used to determine which characteristics were significant predictors of use. Results from the 2 tests did not differ; results from the Wald *F* test are presented in Table 3. Linear trend tests were performed to determine if the probability of intake increased with income or age.

To place these results of dietary supplement use in children in perspective with life span use in the United States, we separately plotted the 1999-2002 NHANES data for all ages from 0 to 85 years and use of any dietary supplement by year of age

Table 2. Dietary Supplement Use and Nutrient Intake From Dietary Supplements in US Children, NHANES 1999-2002[a]

Characteristic	Prevalence of Dietary Supplement and Nutrient Intake, % (SE)							
	Any Dietary Supplement	Multivitamin/ Multimineral Supplement	Calcium	Iron	Fluoride	Retinol	Ascorbic Acid	Vitamin D
Total	31.8 (1.3)	18.3 (0.9)	21.1 (0.9)	19.3 (0.8)	3.0 (0.7)	25.8 (1.1)	28.6 (1.1)	25.6 (1.1)
Sex								
M	30.8 (1.3)	17.5 (1.2)	19.9 (1.2)	18.3 (1.0)	2.9 (0.7)	24.7 (1.3)	27.6 (1.3)	24.6 (1.3)
F	32.8 (1.8)	19.1 (1.0)	22.3 (0.9)	20.4 (1.0)	3.1 (0.8)	27.0 (1.3)	29.5 (1.4)	26.7 (1.2)
Age, mo (y)								
0-11 (< 1)[b]	11.9 (1.5)[c]	0.6 (0.3)[c,d]	0.1 (0.1)[c,d]	2.7 (0.6)[c]	5.8 (1.3)[c]	8.8 (1.3)[c]	8.8 (1.3)[c]	8.7 (1.3)[c]
12-47 (1- 3)	38.4 (2.3)[e]	18.3 (1.5)[e]	20.1 (1.8)	21.1 (1.5)[e]	6.6 (1.8)[e]	33.0 (2.0)[e]	33.7 (2.1)[e]	33.0 (2.0)[e]
48-107 (4-8)	40.6 (2.7)	25.3 (2.0)	26.5 (2.1)	27.0 (1.9)	4.8 (1.1)	36.7 (2.4)	38.1 (2.3)	36.2 (2.4)
108-167 (9-13)	28.9 (1.6)	18.5 (1.6)	22.0 (1.6)	19.1 (1.5)	1.5 (0.4)	24.0 (1.5)	27.1 (1.6)	23.4 (1.5)
168-227 (14-18)	25.7 (1.2)	14.2 (0.7)	19.2 (1.0)	13.8 (0.7)	0.1 (0.1)[d]	15.6 (0.8)	21.2 (1.0)	16.0 (0.8)
Race/ethnicity								
Non-Hispanic White	38.3 (1.8)[c]	22.7 (1.5)[c]	26.0 (1.3)[c]	23.1 (1.1)[c]	3.8 (1.0)	31.4 (1.6)[c]	34.9 (1.6)[c]	31.0 (1.6)[c]
Non-Hispanic Black	18.8 (1.2)	9.4 (0.9)	10.9 (0.9)	11.3 (0.9)	0.8 (0.3)[d]	15.5 (1.1)	16.8 (1.2)	15.5 (1.1)
Mexican American	22.4 (1.3)	13.0 (0.9)	14.8 (0.8)	14.7 (0.9)	2.2 (0.6)	18.5 (0.9)	19.5 (1.0)	18.6 (0.9)
Other	25.4 (2.5)	12.9 (1.6)	16.0 (1.8)	15.3 (1.8)	2.8 (1.2)[d]	18.8 (2.2)	21.4 (2.1)	19.0 (2.2)
Annual family income, $								
0-24 999	21.7 (1.4)[c,e]	11.5 (0.8)[c,e]	14.2 (1.0)[c,e]	13.4 (0.8)[c,e]	1.8 (0.6)[d]	16.7 (1.0)[c,e]	18.6 (1.0)[c,e]	16.7 (1.1)[c,e]
25 000-44 999	32.6 (2.9)	18.0 (1.4)	21.2 (1.6)	19.1 (1.4)	3.7 (1.2)	27.0 (2.5)	29.1 (2.5)	27.5 (2.5)
45 000-64 999	35.5 (2.4)	21.3 (2.0)	23.5 (1.6)	21.6 (1.7)	2.9 (1.1)[d]	29.5 (2.0)	33.1 (2.5)	29.8 (2.1)
≥ 65 000	42.2 (2.1)	26.2 (1.9)	29.7 (1.9)	25.7 (1.8)	4.1 (1.0)	35.2 (1.9)	38.7 (2.0)	34.9 (1.9)
Health insurance								
Yes	32.7 (1.4)	18.8 (1.0)	21.8 (0.9)[c]	19.8 (0.8)	3.3 (0.8)	26.7 (1.2)[c]	29.6 (1.2)[c]	26.9 (1.1)[c]
No	24.6 (3.0)	13.6 (2.1)	15.5 (1.9)	14.4 (2.1)	1.3 (0.9)	18.1 (2.3)	20.6 (2.6)	17.9 (2.6)
Household WIC certified in last 12 mo								
Yes	21.8 (1.6)[c]	11.1 (1.2)[c]	12.1 (1.1)[c]	12.7 (1.2)[c]	3.8 (1.0)	18.2 (1.5)[c]	18.5 (1.6)[c]	18.2 (1.5)[c]
No	34.2 (1.5)	19.9 (1.2)	23.2 (1.0)	20.7 (1.0)	2.9 (0.8)	27.5 (1.3)	30.9 (1.4)	27.6 (1.3)
Smoker in household								
Yes	23.8 (1.7)[c]	13.4 (1.7)[c]	16.1 (1.7)[c]	14.7 (1.4)[c]	0.8 (0.4)[c,d]	18.6 (1.6)[c]	21.5 (1.7)[c]	18.4 (1.6)[c]
No	34.0 (1.5)	19.5 (1.0)	22.4 (0.9)	20.4 (0.9)	3.7 (0.8)	27.7 (1.2)	30.4 (1.3)	27.9 (1.3)
Child total screen time, h/d								
< 1	38.8 (3.4)[c]	21.0 (2.8)	23.2 (2.9)	21.1 (3.0)	4.9 (1.6)	28.8 (3.1)[c]	33.4 (2.9)[c]	27.0 (2.8)[c]
1-2	37.3 (1.9)	21.8 (1.4)	24.6 (1.4)	22.6 (1.1)	2.9 (0.9)	30.9 (1.7)	33.9 (1.7)	30.9 (1.7)
≥ 3	28.6 (1.3)	18.1 (1.4)	21.9 (1.2)	19.3 (1.2)	2.0 (0.5)	23.7 (1.3)	26.1 (1.3)	23.8 (1.3)
Body mass index[f]								
Underweight	38.9 (3.3)[c]	19.0 (3.7)[c]	24.7 (3.3)	25.4 (3.2)	2.0 (1.3)	31.6 (3.4)[c]	33.0 (3.3)	30.3 (3.1)[c]
At risk of underweight	38.8 (3.7)	25.5 (3.0)	27.1 (3.1)	27.7 (3.3)	3.2 (1.6)[d]	31.5 (3.0)	35.7 (3.2)	31.8 (3.0)
Probably a healthy weight	35.0 (1.6)	21.0 (1.2)	24.0 (1.2)	21.4 (1.2)	2.8 (0.8)	28.6 (1.5)	31.7 (1.5)	28.2 (1.5)
At risk of overweight	30.4 (2.2)	18.3 (2.1)	21.9 (2.3)	19.1 (2.1)	1.4 (0.5)[d]	23.1 (2.0)	26.8 (2.1)	23.2 (2.0)
Overweight	25.1 (2.3)	14.1 (1.8)	19.0 (2.2)	15.0 (1.7)	1.7 (0.6)	19.7 (2.1)	22.6 (2.1)	19.7 (2.1)

Abbreviations: NHANES, National Health and Nutrition Examination Survey; WIC, US Department of Agriculture Special Supplemental Nutrition Program for Women, Infants and Children.

[a] Sample weights were poststratified to the 2000 US Census Bureau estimates of the population.

[b] Infants younger than 1 year were not included in the linear trend analysis.

[c] χ^2 Tests were conducted within each characteristic for supplement types (any dietary supplement vs multivitamin and multimineral) and specific nutrients. χ^2 Test of prevalence within this variable was significant ($P \leq .005$).

[d] Standard errors do not meet the standard of statistical reliability and precision (relative SE > 30%).

[e] A linear trend test for this variable was significant ($P \leq .005$).

[f] Calculated as weight in kilograms divided by height in meters squared.

for children and 5-year age increments for adults (**Figure**). Trend analyses were conducted separately on curves for children (age, 0-18 years) and adults (age, 19-85 years).

RESULTS

Nearly one-third of children (31.8%) used any dietary supplement in the past month, with no significant sex differences (Table 2). When supplements were categorized based on ingredients, 18.3% said they used multivitamin and multimineral supplements. Use of other dietary supplement types was much lower: 4.2% for single vitamins, 2.4% for single minerals, and 0.8% for any botanical supplements, with no significant differences by sex. The remaining 6.1% of supplement use was divided among a (1) diverse array of other supplement types com-

Table 3. Multivariate Analyses of Characteristics Associated With Selected Nutrient Intake From Dietary Supplements, NHANES 1999-2002[a]

Characteristic	Odds Ratio (95% Confidence Interval)							
	Any Dietary Supplement	Multivitamin/ Multimineral Supplement	Calcium	Fluoride	Iron	Retinol	Ascorbic Acid	Vitamin D
Age, mo (y)								
12-47 (1-3)	1 [Reference][b,c]	1 [Reference][b]	1 [Reference]	1 [Reference][b,c]	1 [Reference][b]	1 [Reference][b,c]	1 [Reference][b]	1 [Reference][b,c]
48-107 (4-8)	1.1 (0.8-1.4)	1.9 (1.3-2.7)	1.7 (1.2-2.4)	0.7 (0.5-1.0)	1.6 (1.2-2.2)	1.5 (0.8-2.7)	2.0 (1.0-4.1)	1.5 (0.8,2.6)
108-167 (9-13)	0.6 (0.5-0.7)	1.9 (1.2-3.1)	1.8 (1.1-3.1)	0.3 (0.1-0.5)	1.6 (1.1-2.3)	0.8 (0.4-1.5)	2.0 (1.0-3.7)	0.8 (0.4-1.4)
168-227 (14-18)	0.5 (0.4-0.6)	1.4 (0.9-2.1)	1.6 (1.0-2.5)	0	1.0 (0.6-1.5)	0.3 (0.1-0.5)	0.6 (0.3-1.3)	0.3 (0.1-0.6)
Race/ethnicity								
Non-Hispanic White	1 [Reference][b]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic Black	0.4 (0.3,0.5)	0.7 (0.5,1.0)	0.7 (0.5-1.1)	0.3 (0.2-0.7)	1.0 (0.7-1.3)	1.0 (0.6-1.6)	0.8 (0.5-1.4)	0.9 (0.6-1.5)
Mexican American	0.6 (0.4,0.7)	1.1 (0.8,1.4)	1.3 (0.9-1.8)	0.7 (0.4-1.2)	1.4 (1.1-1.8)	1.1 (0.7-1.9)	0.8 (0.5-1.4)	1.1 (0.7-1.8)
Other	0.6 (0.5,0.8)	0.7 (0.5,1.2)	0.8 (0.5-1.2)	1.1 (0.4-3.1)	1.0 (0.6-1.7)	0.6 (0.3-1.1)	0.6 (0.2-1.3)	0.6 (0.3-1.1)
Annual family income, $								
0-24 999	1 [Reference][b,c]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
25 000-44 999	1.4 (1.1-1.9)	1.0 (0.7-1.5)	1.0 (0.7-1.5)	1.5 (0.8-3.2)	0.9 (0.6-1.4)	1.5 (1.1-2.2)	1.3 (0.8-2.1)	1.7 (1.1-2.5)
45 000-64 999	1.5 (1.2-2.0)	1.3 (0.8-2.1)	0.9 (0.6-1.5)	1.2 (0.5-2.8)	1.0 (0.6-1.6)	1.7 (0.9-3.2)	2.2 (1.1-4.1)	1.8 (1.1-2.9)
$\geq$ 65 000	1.8 (1.4-2.3)	1.4 (0.9-2.1)	1.3 (0.8-2.0)	1.5 (0.7-3.4)	1.0 (0.7-1.6)	1.9 (1.2-2.8)	1.8 (1.1-2.9)	1.6 (1.1-2.6)
Smoker in the household								
Yes	1 [Reference][b]	1 [Reference]	1 [Reference]	1 [Reference][b]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
No	1.5 (1.2-1.9)	0.9 (0.6-1.3)	0.9 (0.6-1.3)	3.4 (1.5-7.8)	0.9 (0.6-1.2)	0.9 (0.7-1.4)	0.7 (0.4-1.4)	1.1 (0.8-1.7)
Household WIC certified in the last 12 mo								
Yes	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
No	1.3 (1.0-1.7)	0.9 (0.5-1.6)	1.1 (0.6-1.8)	0.4 (0.2-0.9)	1.0 (0.5-1.9)	0.7 (0.3-1.6)	1.1 (0.5-2.3)	0.7 (0.3-1.7)

Abbreviations: NHANES, National Health and Nutrition Examination Survey; WIC, US Department of Agriculture Special Supplemental Nutrition Program for Women, Infants and Children.

[a] Characteristics were selected and entered into the model logically based on the statistical significance of the intake prevalence. The model did not include children younger than 1 year (1040 in sample, 112 of whom used supplements), because there were too few in this age group for accurate computation. Odds ratios are adjusted for all characteristics presented in the table.

[b] Wald F test of prevalence was significant ($P \leq .005$).

[c] Linear trend is significant ($P \leq .005$).

posed of single nutrients or (2) very low frequency of use of complex ingredient combinations, including multivitamins, multiminerals, botanicals, and supplements with proprietary blends (40 separate dietary supplement types in 1999-2000 and 44 types in 2001-2002). The most commonly used botanical supplements were citrus bioflavonoids, ginseng, echinacea, ginkgo, and grape seed extract. Type of supplement use differed significantly by age for all categories of dietary supplements with the exception of single minerals ($P < .005$).

The prevalence of dietary supplement use was lowest (12%) in the first year, highest among young children, and declined among adolescents (38% for children aged 1-3 years, 40% for children aged 4-8 years, 29% for children aged 9-13 years, and 26% among teenagers 14-18 years old) (Table 2). When infants were excluded, intake of any dietary supplements and multivitamins/multiminerals showed a significant linear downward trend with increased categorical age ($P < .005$).

When we separately plotted intake of any dietary supplement by age, data conformed to a quadratic relationship ($P < .005$); prevalence increased from infancy with a peak at 5 years of age (40%), then declined in the teenage years, as shown in the Figure. We placed supplement use by children into the context of use across all ages by also plotting the prevalence and SE of adult supplement use by 5-year increments, from the same NHANES series (1999-2002) (Figure). In contrast to children, there is a significant ($P < .005$) linear trend in prevalence of supplement use for adults aged from 19 to 65 years, with the highest prevalence in persons older than 65 years. Overall, prevalence of any supplement use in the last 30 days increased from infancy to 40% in 5-year-old children, followed by a decrease among teenagers, then a steady increase in 5-year age increments through adulthood to age 65 years, where prevalence leveled off.

Table 2 summarizes the prevalence of supplement use and intake of key nutrients from supplements by children, as related to demographic and household characteristics. More than 20% of US children take a dietary supplement regularly, whether multivitamin/multimineral, single nutrient, or various combinations of nutrients and other supplement ingredients that contain retinol, ascorbic acid, and vitamin D. Iron, which has long been of concern in child health, is taken as a supplement by approximately 19% of children. Supplemental fluoride is used by relatively few children (3.0%). When infants were omitted, significant age differences in the intakes of retinol, ascorbic acid, vitamin D, fluoride, and iron followed the same trend as that of multivitamin use, with an overall downward trend with increased categorical age through the teenage years ($P < .005$). Intake prevalence of supplements and all nutrients from supplements, with the exception of fluoride, was highest among children aged 4 to 8 years.

The use of any dietary supplements, multivitamin and multimineral supplements, and supplements containing retinol, ascorbic acid, vitamin D, calcium, and iron

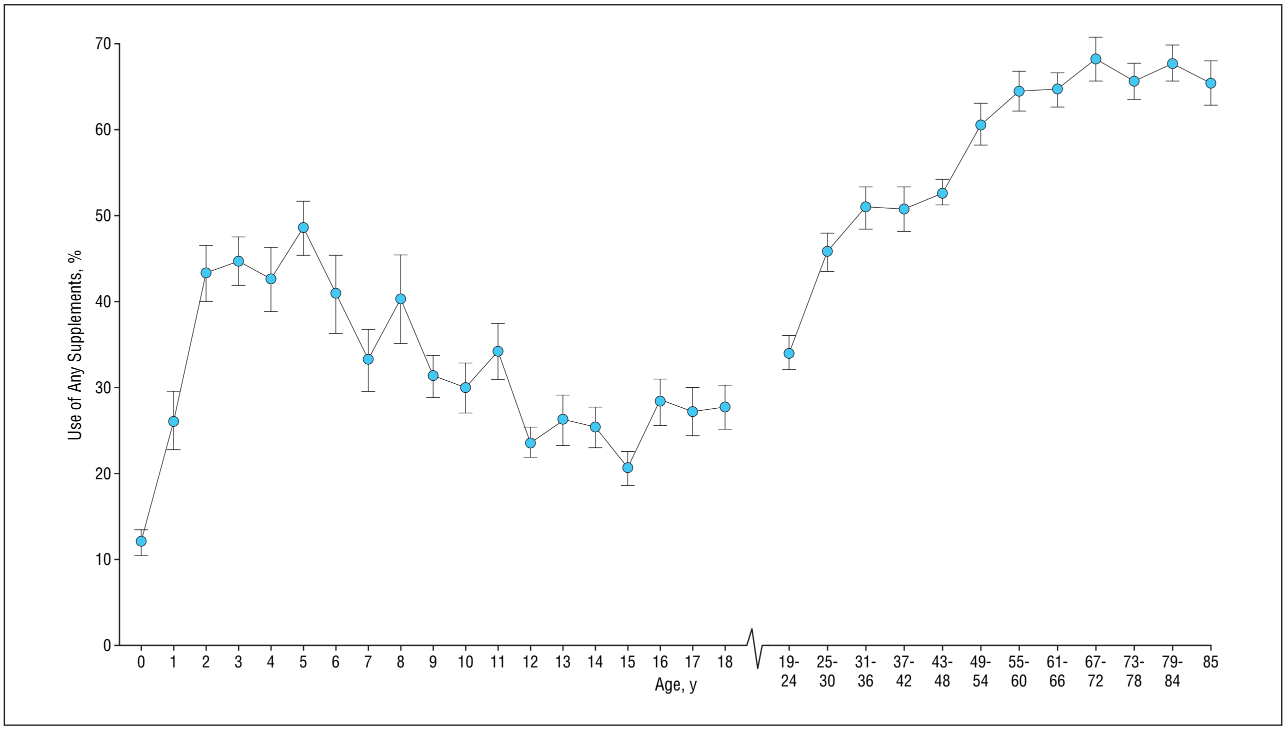

Figure. Prevalence and SE (error bars) of dietary supplement use among infants, children, adolescents, and adults in the past 30 days.

was highest among non-Hispanic white children and lowest among non-Hispanic black children ($P < .005$). Prevalence of use increased significantly with annual family income ($P < .005$) and was significantly higher in households that were not eligible for WIC in the past 12 months ($P < .005$) and in families where no one in the household smoked ($P < .005$). Linear trend analysis was significant ($P < .005$) for categorical family income for the use of any dietary supplements, multivitamin and multimineral supplements, and intake of retinol, ascorbic acid, vitamin D, fluoride, and iron.

Children in families with health insurance were significantly more likely to use supplements that contained retinol, ascorbic acid, vitamin D, and calcium ($P < .005$). Children who engaged in more hours of combined recreational television, video game, and/or computer game use per day had a lower prevalence of use of any dietary supplements and lower intakes of retinol, ascorbic acid, and vitamin D from supplements ($P < .005$). With the exception of fluoride intake, use of any supplement, use of multivitamins and multiminerals, and nutrient intake from supplements was higher in children with lower BMIs. This association reached statistical significance with children's use of any dietary supplement and multivitamin and minerals, as well as intakes of retinol and vitamin D from dietary supplements ($P < .005$).

Additional analyses demonstrated that children who used supplements took them regularly, with more than 50% having taken a supplement 30 times in the past month and more than 60% having taken supplements for at least 12 months. Among children who used supplements, an estimated 83.9% took 1 supplement, 11.8% took 2, and 4.3% took 3 or more. Teenagers (age, 14-18 years) were significantly more likely to have taken 2 or more supplements compared with younger children ($P < .005$). Non-Hispanic black children were the least likely to take more than 1 supplement ($P < .005$).

Table 3 presents a multivariate model analysis of the adjusted odds ratios with 95% confidence intervals for demographic and household variables. A child's age was significantly associated with use of any dietary supplement, multivitamins and multiminerals, and intake of iron, fluoride, retinol, ascorbic acid, and vitamin D from supplements ($P < .005$). There was a statistically significant linear decrease with increasing age for use of any dietary supplement and intake of fluoride, retinol, and vitamin D from supplements ($P < .005$). Significant ($P < .005$) positive associations for use of any dietary supplement were apparent for non-Hispanic white children, for children from families with higher incomes, and for households without smokers.

COMMENT

Dietary supplement use has increased among adults in recent years,[6] yet it appears to have remained relatively constant or to have declined in children. This population-based survey indicated that about one-third of US children took supplements in 1999-2002. The prevalence of supplement use increases from low levels in infants and young children to about 49% for 5-year-old children, followed by a steady decline to 20% among 15-year-old adolescents, with an increase among older teenagers (28%) and into young adulthood (Figure). These data are the first to include information on the use of botanical as well as nutrient-containing dietary supplements among children. Few children younger than 3 years used botanical supplements, and the maximum prevalence was only 1% in teenagers. Use of botanicals and specialty supplements show up primarily in some smaller, location-specific studies, but the national data presented here suggests that such use is neither widespread nor uniform.[40-42]

Supplement use among teenagers appears to have remained relatively constant since it was first recorded by NHANES in the 1970s.[31,43] In contrast, there appears to have been a decline in supplement use among nationally representative samples of young children, from roughly 50% of children aged 1 to 3 years from the 1970s to the mid-1990s[27-31] to 38% in our study. In part, this may be because of revisions in infant formulas after the Infant Formula Act of 1980, which are now fortified with iron, vitamin D, and other nutrients, making them complete foods for infants.

Multivitamins and multiminerals remain the most commonly consumed type of dietary supplement in all pediatric age groups,[26,30,31,43,44] with more than 25% of children overall receiving retinol, ascorbic acid, and vitamin D from these products. As was found in earlier studies,[30] most children take only 1 dietary supplement. As in NHANES III[30] and among adults in the 1999-2000 survey,[6] supplement users and nonusers differed in specific characteristics. Dietary supplement use was highest among non-Hispanic white children, those from higher-income families, those whose families were not eligible for WIC, those who had nonsmoking environments, and children who engaged in less video and television use.

Children in the lowest BMI categories and at highest risk of underweight had the highest prevalence of supplement use, which was significantly higher than for overweight children. The follow-up to the 1988 National Maternal and Infant Health Survey did not include BMI but found that children aged 3 years who used supplements had similar familial and lifestyle profiles and were more often reported to have eating problems or poor appetites.[27] Young children at the lowest BMI for age (near or below the 5% level of weight for height-reference categories) might appear thin to parents and other caretakers and might be given more dietary supplements to "make them healthy." These findings support previous suppositions that supplement use in young children is based on caregivers' perception of the health of the child and their own dietary beliefs.[27] An alternative explanation might be that children with lower BMIs are more likely to be part of health-oriented families and therefore be more physically active and spend less time at sedentary, screen-related recreation.

With the exception of infants, we found the lowest prevalence of supplement use in older teenagers (age, 14-18 years). Other studies have found that young teenagers who do not take supplements have diets that are less likely to meet national dietary guidelines and to be at risk for consuming less than recommended amounts of nutrients.[24,44,45]

Current pediatric recommendations are for children to receive their nutrients principally from diet with supplementation in specific situations, such as supplemental fluoride in areas only where there are no or suboptimal amounts of fluoride in the drinking water[46] and vitamin and/or mineral supplements for children at risk of specific nutrient deficiencies because of their age and/or life situations.[12,13,19-22] Our analysis indicates that approximately 30% of children receive dietary supplements and that the highest prevalence of nutrient intakes from these products are for retinol, ascorbic acid, vitamin D, calcium, and iron. Calcium, vitamin D, and iron are nutrients of most concern for healthy childhood development and bone growth and are often consumed in lower than recommended amounts.[12,13,19-22,43,45] The limited use of fluoride supplements by children in this analysis may reflect physician and dental practitioner concerns about excess fluoride intakes associated with dental fluorosis.[46]

These data also illustrate that children in higher-income families, children with less recreational screen time, and children in smoke-free households are most likely to use supplements. In contrast, children in families with lower income, non-Hispanic black children, children in families without heath insurance, children in households where people smoke, and children who spend more time engaged in recreational screen time are the least likely to take supplements. Adults who use dietary supplements have been described as similarly differing from nonusers in lifestyle, demographic, health, and dietary characteristics.[6,10,11]

The strength of NHANES data on supplement use is that information is recorded directly from the label by trained interviewers in participants' homes, the data are reviewed by NHANES nutritionists, and the data can be used for nationally representative group estimates. Limitations of this study include the cross-sectional design of NHANES; respondent reporting errors caused by use of proxies for those younger than 16 years; and differences in definitions and methodology over time, which limit comparisons of prevalence data regarding dietary supplement use among different survey cycles within NHANES and with other nationally representative samples, such as the Continuing Survey of Food Intake by Individuals and the National Maternal and Infant Health Survey.[3,26,28]

In conclusion, dietary supplements provide a consistent daily source of nutrients for nearly one-third of US children, yet individual and national-level estimates of nutrient intake rarely account for them.[44,47,48] Dietary Reference Intakes[34] and Dietary Guidelines for Americans[49] provide recommended nutrient intakes and advice on food choices that promote health and reduce the risk of disease. To truly assess the nutrient status and estimate the potential health risks of US children, we must include nutrient intakes from dietary supplements as well as from food.

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